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IMPROVING NEUTRON MEASUREMENT CAPABILITIES; EXPANDING THE LIMITS OF CORRELATED NEUTRON COUNTING

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Project Description

A number of technical and practical limitations exist within the neutron correlated counting techniques used in safeguards, especially within the algorithms that are used to process and analyze the detected neutron signals. A multi-laboratory effort is underway to develop new and improved analysis and data processing algorithms based on fundamental physics principles to extract additional or more accurate information about nuclear material bearing items.

Benefit

Enhance current SNM assay capabilities through the extraction and utilization of higher order moments in order to obtain more accurate and/or complete information on SNM properties.

Applications

Developed improved analysis algorithms for neutron correlated counting would be applicable to:

- International Safeguards (IAEA, Euratom, etc.)
- Treaty Verification
- Emergency Response

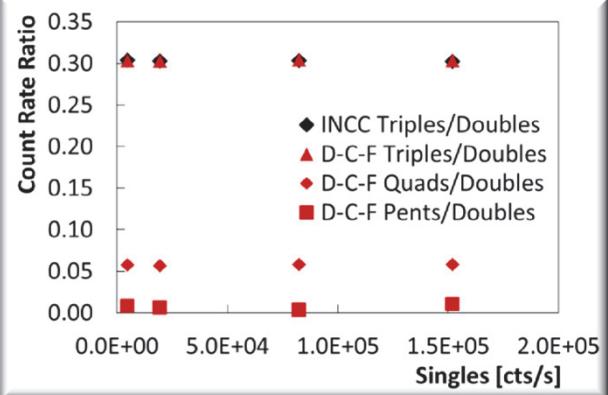
Accomplishments

Expanded multiplicity counting capabilities to allow extraction of higher order moments (Quads and Pents) and developed advanced dead time correction algorithms (Dytlewski-Croft-Favalli, CNDTM) to correct for dead time losses including higher order moments. (Current capabilities only allow extraction of multiplicity moments up to Triples.)

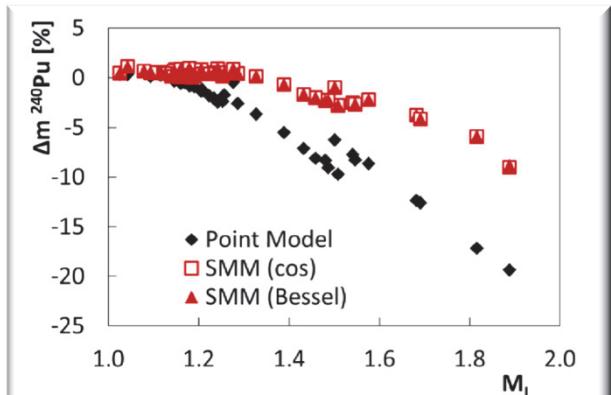
Developed advanced models (Spatial Multiplication and Two Energy Multiplicity models) to utilize higher order moments for SNM assay.

Established a link between the shift register analysis and Feynman-variance to allow extension of correlated data analysis to include range of gating schemes. (Current capabilities allow a single type of correlated data analysis.)

Developed high-fidelity simulation capability to allow more realistic characterization of effects of detection system electronics (dead time and double pulsing).



Count rate ratios for a series of Cf sources measured in the ARIES counter. The data demonstrate the effectiveness of the Dytlewski-Croft-Favalli (D-C-F) dead time correction on Quads and Pents.



Relative difference between assayed and true ^{240}Pu mass for range of leakage multiplications from simulated assay. The results illustrate the improvement of ^{240}Pu mass accuracy when calculated using Spatial Multiplication Model (SMM) over standard Point Model.

Anticipated Final Capabilities

The end product will include a suite of advanced algorithms and simulation tools that could make fundamental improvements to the current measurement and simulation capabilities, specifically:

- Dead time correction algorithms for the accurate extraction of higher order moments (Quads and Pents).
- Advanced analysis algorithms for higher accuracy and precision in SNM assay by using higher order moments.
- Capability to extract traditional multiplicity rates using range of gating schemes.
- High-fidelity simulation capability to allow more accurate representation of experimental data.

Further Reading

P. Santi, et al., "The Development of Advanced Processing and Analysis Algorithms for Improved Neutron Multiplicity Measurements", IAEA Symposium on International Safeguards, Vienna, Oct 20-24, 2014. LA-UR-14-27095.